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# BMJ Open Overweight and obesity on the island of Ireland: an estimation of costs

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## ABSTRACT

**Objectives:** The increasing prevalence of overweight and obesity worldwide continues to compromise population health and creates a wider societal cost in terms of productivity loss and premature mortality. Despite extensive international literature on the cost of overweight and obesity, findings are inconsistent between Europe and the USA, and particularly within Europe. Studies vary on issues of focus, specific costs and methods. This study aims to estimate the healthcare and productivity costs of overweight and obesity for the island of Ireland in 2009, using both top-down and bottom-up approaches.

**Methods:** Costs were estimated across four categories: healthcare utilisation, drug costs, work absenteeism and premature mortality. Healthcare costs were estimated using Population Attributable Fractions (PAFs). PAFs were applied to national cost data for hospital care and drug prescribing. PAFs were also applied to social welfare and national mortality data to estimate productivity costs due to absenteeism and premature mortality.

**Results:** The healthcare costs of overweight and obesity in 2009 were estimated at €437 million for the Republic of Ireland (ROI) and €127.41 million for NI. Productivity loss due to overweight and obesity was up to €865 million for ROI and €362 million for NI. The main drivers of healthcare costs are cardiovascular disease, type II diabetes, colon cancer, stroke and gallbladder disease. In terms of absenteeism, low back pain is the main driver in both jurisdictions, and for productivity loss due to premature mortality the primary driver of cost is coronary heart disease.

**Conclusions:** The costs are substantial, and urgent public health action is required in Ireland to address the problem of increasing prevalence of overweight and obesity, which if left unchecked will lead to unsustainable cost escalation within the health service and unacceptable societal costs.

## INTRODUCTION

The increasing prevalence of overweight and obesity in recent decades poses significant threats to the health and well-being of populations and represents a major challenge for health services. In a systematic analysis of data

## Strengths and limitations of this study

- This study provides a significant contribution to the existing evidence base as it is the first extensive investigation of the cost associated with overweight and obesity on the island of Ireland, enabling comparisons to be made across both jurisdictions.
- The healthcare and lost productivity costs of overweight and obesity are examined in the study which further enhances the robust scope of the research.
- Omitted from the analysis were several aspects of service where additional demand is likely to emerge as a result of overweight and obesity, that is, long-term care, social care, personal social services and dietician services. Costs that fall on the individual rather than the health service were also omitted. Owing to the absence of adequate reliable data on which to base estimates, the derived summary cost estimates are likely to be conservative.

from 199 countries, it was estimated that 1.46 billion adults worldwide were overweight in 2008, of which 502 million were obese.<sup>1</sup> Trends over the past 20 years in the USA suggest that the number of people in the highest body mass index (BMI) group is increasing faster than any other group. From 2000 to 2005, the estimated prevalence of obesity in the USA based on self-reported height and weight increased by 24%. However, the prevalence of morbid obesity (BMI >40 kg/m<sup>2</sup>) increased by 50% and the prevalence of a BMI of over 50 kg/m<sup>2</sup> increased by 75%, during this period in the USA.<sup>2</sup>

In the Republic of Ireland (ROI), the 2007 Survey of Lifestyle, Attitudes and Nutrition in Ireland (SLÁN) provides estimates of BMI based on self-reported height and weight<sup>3</sup> (Ireland refers to the ROI, while Northern Ireland (NI) refers to the Northern part of Ireland which is part of the UK, and the Island of Ireland refers to the whole) More than

one-third of respondents (36%) were classified as overweight (43% of men and 28% of women) and 14% as obese (16% of men and 13% of women), while a measured subset showed the prevalence to be 39% overweight and 25% obese. More recent data on the prevalence of overweight and obesity in adults aged 50+ years in the ROI using measured BMI<sup>4</sup> reported a prevalence of overweight of 47% in men and 40% in women, and a prevalence of obesity of 37% in men and 31% in women aged 50+ years. Results from the Health Survey for Northern Ireland 2011 have also revealed similar prevalence rates for NI with 36% of adults reported as overweight and 23% as obese.<sup>5</sup>

Overweight and obesity are implicated in the aetiology of a large number of medical conditions. They are associated with significantly increased risk of type II diabetes, cardiovascular disease, several cancers and a number of additional chronic conditions.<sup>6</sup> The WHO has described chronic disease (mainly cardiovascular disease, diabetes, asthma and chronic obstructive pulmonary disease) as the 'leading threat to human health and development'.<sup>7</sup> The WHO's project, *the Global Burden of Disease*, has estimated that chronic diseases are the largest contributor to mortality and disability in high-income countries and that by 2030, 89% of disability adjusted life years (DALYs) will be attributed to chronic conditions.<sup>7</sup>

Estimates of the economic burden of illness can provide useful information for priority setting, policy development, assessment of health technologies and investment in prevention and clinical services. Health systems worldwide are struggling to meet the challenge of increasing demand for healthcare and of increasing expense with diminishing resources. Cost of illness studies for major health risks such as overweight and obesity therefore have the potential to frame core policy issues in language that is tangible and accessible to policymakers. International cost of illness estimates of overweight and obesity have demonstrated substantial costs. The published estimates for the healthcare cost of increased BMI in the UK range from approximately £3.2 Billion to £4.2 Billion.<sup>8 9</sup> These figures represent around 5% of the total healthcare spending in the UK for the years concerned. In similar studies, it has been estimated that in the USA between 4.8%<sup>10</sup> and over 9%<sup>11</sup> of total healthcare spending is due to overweight and obesity-related illness.

Few estimates exist for the costs associated with overweight and obesity for Ireland. The costs in terms of hospital inpatient stays only were estimated at €4.4 million in 1997, rising to €13.3 million in 2004.<sup>12</sup> The National Taskforce on Obesity estimated that the direct healthcare cost of obesity in Ireland in 2002 was €70 million, and the indirect cost was €0.37 billion, giving a total cost of €0.4 billion.<sup>13</sup> However, this estimate was based mainly on data from the UK, which were adjusted for Ireland, with limited data from the Irish Hospital Inpatient Enquiry (HIPE) database included. In NI, there is a relative paucity of cost data to help inform policy

responses. Given Ireland's health service and population characteristics, it is difficult to reliably estimate the cost of illness by extrapolation from published international data. Furthermore, much of the previous literature focused only on healthcare costs of obesity, productivity costs being largely ignored. The aim of this paper is to provide a comprehensive estimate of the healthcare and productivity costs of overweight and obesity in the ROI and NI in 2009. Decomposing differences in cost on the two parts of the island would provide an interesting and useful exercise in, for example, investigating the impact on healthcare costs that differences in access to public services might have. As this was not the focus of this paper and mindful of constraints on space, we have chosen not to provide such an analysis here.

## MATERIALS AND METHODS

We adopted a societal perspective (ie, that includes healthcare costs and lost productivity) in estimating the economic cost of overweight and obesity. We focused on estimating costs across four key categories: healthcare utilisation, drug costs, work absenteeism and premature mortality. We used population attributable fractions (PAFs) calculated by age and gender and applied to national cost data analysis of hospital inpatient, day cases and also prescribing data in the ROI and NI. Similarly, PAFs were applied to social welfare (SW) data and to national mortality data to calculate the productivity costs due to absenteeism and premature mortality. There were no data availability for which general practitioner (GP) costs could be analysed from a top-down approach, so we based our estimates on work previously carried out by this group, using a bottom-up approach.<sup>14 15</sup> Table 1 outlines the data sources used in this study.

### Population attributable fractions

In this study, PAFs were calculated using the following formula which accounts for multiple levels of exposure:<sup>21</sup>

$$PAF = \frac{PF_1\{RR_1 - 1\} + PF_2\{RR_2 - 1\}}{1 + PF_1\{RR_1 - 1\} + PF_2\{RR_2 - 1\}}$$

where  $PF_1$  is the fraction of the population in exposure level 1 (eg, overweight),  $RR_1$  is the relative risk of disease for exposure level 1,  $PF_2$  is the fraction of the population in exposure level 2 (eg, obese) and  $RR_2$  is the relative risk of disease for exposure level 2. All the PAFs used in these calculations were based on measured BMI prevalence rates, calculated from the measured subset of the SLÁN survey for the ROI and the 2010/2011 Health Survey Northern Ireland, and using RRs from the international literature as outlined in table 1. PAFs were calculated by the 5-year age group for ROI and the 10-year age groups for NI, separately for males and females for each condition including low back pain, osteoarthritis, coronary artery disease and stroke.

**Table 1** Data sources used in this study

Categories	Data	Source
Healthcare utilisation	Population prevalence of overweight and obesity	SLÁN <sup>3</sup>
		TILDA Wave 1, 2010 <sup>4</sup>
		Health Survey for Northern Ireland 2011 <sup>5</sup>
	GP costs	Doherty <i>et al</i> , <sup>15</sup> Dee, A <sup>14</sup>
	Hospital inpatient and day-case costs	HIPE
	Relative risks (RRs)	HIS
Drug costs	Drug costs	Guh <i>et al</i> <sup>6</sup>
		Parkin and Boyd <sup>16</sup>
Work absenteeism	Average wages	Bhole <i>et al</i> <sup>17</sup>
		Pomp <i>et al</i> <sup>18</sup>
Premature mortality	Mortality	PCRS
		Central Statistics Office (CSO) <sup>19 20</sup>
		Department of Social Protection illness benefit data for 2009
		Department of Social Development (Northern Ireland)
		CSO (Central Statistics Office) mortality data for 2007 to 2009
		Northern Ireland Statistics and Research Agency (NIRSA)

GP, general practitioner; HIPE, Hospital Inpatient Enquiry; HIS, Hospital Inpatient Statistics; PCRS, Primary Care Reimbursement Service; SLÁN, Survey of Lifestyle, Attitudes and Nutrition.

### Healthcare utilisation

For hospital inpatient and day cases, PAFs of the specific overweight and obesity-related conditions were applied to the Hospital Inpatient Enquiry (HIPE) database for the ROI, and Hospital Inpatient Statistics (HIS) data for NI. HIPE in the ROI and HIS in NI are the primary sources of national data on discharges from acute hospitals and collect demographic, clinical and administrative data on discharges from and deaths in acute public hospitals nationally.<sup>1</sup> In both data sets, the diagnosis related groups (DRGs) are the cost groups for patient discharges, and for each condition they were summed by 5-year age group and gender. The PAFs for overweight and obesity-related conditions were applied to the summed DRGs to give the proportion of costs that could be attributed to overweight and obesity. The International Classification of Diseases (ICD) codes included in these analyses are outlined in [table 2](#).

Our estimates of GP and outpatient costs for the ROI are based on published literature. Doherty *et al*<sup>15</sup> used data from SLÁN 2007 to estimate the impact of overweight and obesity on GP service use and outpatient services. They provide a detailed description of the model used and the regression analyses performed. Briefly, they estimated the difference in the probability of individuals using their GP associated with elevated BMI, controlling for covariates and, based on this, estimated the impact of overweight and obesity on service use. This was then combined with the cost of the service, to estimate the additional cost associated with overweight and obesity. Estimates of average visit frequency for the adult population were taken from

the Quarterly National Household Survey (QNHS) Q3 2007<sup>22</sup> and costs were taken from published sources in the literature; more details of these are given in Doherty *et al*<sup>15</sup>. In the base case analysis, the cost of a GP consultation was estimated at €50, of an inpatient episode at €5030<sup>23</sup> and of an outpatient visit at €139 (personal communication: Mark Connors Casemix unit, HSE). They calculated the cost of GP use associated with overweight and obesity as being €22 900 000.

For NI, we used data from the grey literature that used similar methodology for healthcare costs associated with GP use in NI.<sup>14</sup> In that study, data from the 2010/2011 Health Survey Northern Ireland, which is similar to SLÁN in terms of the issues covered and is based on a

**Table 2** Conditions and codes analysed for hospital inpatient and day-case analysis

Condition	ICD Codes
Cancer of the colon	C18, C19, C20
Cancer of the oesophagus	C15
Cancer of the gallbladder	C23
Cancer of the pancreas	C25
Cancer of the breast	C50
Cancer of the kidney	C64
Type 2 diabetes	E11, E13, E14
Cancer of the endometrium	C54, C55
Obesity	E660, E662, E668, E669
Hypertension	I10, I11, I12, I13
Stroke	G45, I61, I629, I63, I64, I69
Ischaemic heart disease	I20, I21, I22, I23, I24, I25, I46, I50, I70, I71, I72, I74
Gallbladder disease	K80, K81
Pulmonary embolism	I26
Low back pain	M54.3, M54.4, M54.5
Asthma	J45, J46

<sup>1</sup>HIPE data was analysed using the Health Atlas. Health Atlas Ireland is an open source application which enables web-based mapping of national health-related data.



representative sample of households, were used. The unit cost for a GP visit of £36 was taken from standard sources assuming all visits were to the GP surgery within office hours and lasted on average just over 11 min.<sup>24</sup> Adjustment was made using purchasing power parity (PPP) for 2009 to express UK figures into their Irish equivalent for comparison purposes with the ROI. The cost with respect to increased BMI in the case of GP services was €7 411 564.

### Drug costs

Drug cost data for the ROI were obtained from the Primary Care Reimbursement Service (PCRS) and from the Business Services Organisation (BSO) for NI, for the year 2009. The PCRS reimburses community drugs dispensed for those with medical cards (dependent on means test), with long-term chronic illnesses (dependent on diagnosis) and those on high-tech drugs, which three schemes together cover over 50% of the population's drug spend. They also reimburse drug payments in excess of €142 to private patients. The BSO manages prescribing data on behalf of the health service in NI, where all citizens have equal cover. The PAFs calculated were applied to the drug expenditure on drug categories of relevance including drugs used in the treatment of type II diabetes, cardiovascular conditions, aspirin and non-steroidal anti-inflammatory agents (reflecting treatments for osteoarthritis). Drug expenditure included a dispensing fee plus VAT where relevant.

### Work absenteeism

Work absenteeism was calculated using social welfare (SW) data in both jurisdictions. However, the availability and quality of the available data were variable. In ROI, the Department of Social Protection runs three SW schemes which apply to individuals who are unable to work due to illness. One of these deals mainly with disabilities from birth, and was not relevant to the cost of obesity. The other two deal with short-term illnesses from work (the illness benefit scheme (IBS)) and longer term illness causing inability to work on a long-term basis (Invalidity Pension). Both of these schemes have data on work absences that could be related to overweight and obesity, but only data from one scheme (IBS) was available in electronic format. Therefore, we limited our analysis to this scheme.

Claims were assessed to determine if the principal medical condition linked to each claim was likely to be associated with overweight and obesity. The age group and gender-specific PAFs were applied to the duration of illness for each condition, and a productivity loss value was calculated by costing the length of the claim by gender and age group-specific mean total annual earnings for 2009. The IBS data set not only contains short-term claims but also many claims spanning the entire year, which were often found to be initiated long prior to 2009 (historical claims). These historical claims were found to have a large effect on the estimated

productivity loss, and were therefore eliminated following the primary analysis, giving a truncated data set on which subsequent analyses were performed. Claims are not paid until after day 3 of sickness absence in about 90% of cases. Accordingly, 2.7 days (3 days×90%) were added to each claim. By applying PAFs for the relevant conditions, estimates of duration of illness were obtained and were taken as a proxy for lost productivity. Associated costs were estimated by applying average gross national wages for men and women to illness duration attributable to obesity and overweight. For NI, the number of individuals in receipt of a range of benefits was obtained from the Analytical Services Unit of the Department of Social Development (NI) for 2009 by ICD-10 code. Owing to the available data, it was not possible to estimate total duration of time off work (as was performed for the ROI). Therefore, the total amount of benefit payments made for overweight and obesity-related conditions was calculated. Using this information and data on weekly payment rates, the duration of absent days was calculated from which a productivity estimate could be made. It was not possible to eliminate long-term claims from this data set.

A PAF approach was used to estimate the productivity loss costs associated with benefits paid to individuals unable to work due to obesity-related illnesses. The human capital approach counts any hour not worked as an hour lost and takes the perspective of the patient. The friction cost approach takes the employer's perspective and counts only hours not worked up while the employee is being replaced. We estimated both for each jurisdiction. The use of average earnings to estimate lost productivity is open to question. Those who are overweight or obese may experience an earnings penalty related to unobserved characteristics and/or discrimination in the workplace. Rather than speculate as to the magnitude of such effects (and their differences between jurisdictions), we have used the average wage figure but caution as to the interpretation of results.

### Premature mortality

Mortality data were obtained from the Irish Central Statistics Office (CSO) for the ROI and the Registrar General reports for NI covering a 3-year period from 2008 to 2010 inclusive. Deaths for the named conditions were weighted using years of potential life lost (YPLL) up to age 75, and also for all ages. Costs were based on the average income at the age of death, by age and sex, excluding deaths occurring in those under age 18. Thirty per cent of the pre-retirement income, reflecting an approximation of the state pension, was used for people in the 65+ age group. The estimated income at the time of death was used as the income and a discount rate of 4% was applied. All analyses were performed using R. Deaths were manually linked to the ICD-Code 10, described in [table 2](#), which indicated the cause of death in the individual death records obtained from the CSO. For each death record, the relevant overweight and obesity prevalence, and the life expectancy from the

most recent Life Tables, were linked by age and sex to the record. The relevant RRs and their upper and lower CIs were linked by cause of death and sex.

Bottom-up estimates were based on regression analyses in which a range of health and sociodemographic covariates featured in the estimated functions. The resultant cost estimates are based on conditional probabilities of adiposity and in consequence are to be interpreted as incremental costs of adiposity. Similarly, in respect of the top-down estimates of cost, PAFs are based on relative and not absolute risks of morbidity conditional on adiposity and can again be interpreted as incremental costs of adiposity. The two approaches are different, a fact we return to in our limitations section.

The issue regarding the use of average earnings notwithstanding valuing premature death in terms of lost productivity ignores the broader value to society beyond production that individuals make as members of families and social networks. While alternate approaches—for example using the value of a statistical life—may incorporate such elements, their precision is open to question. Moreover, as we have not sought to include monetary values associated with the disutility of obesity-related morbidity (pain, suffering and anxiety), an attempt to include them here could appear inconsistent.

## RESULTS

Table 3 gives the individual results for each part of the analysis. The main drivers of healthcare costs due to drugs and hospital inpatient and day-case care are cardiovascular disease, type II diabetes, colon cancer, stroke and gallbladder disease. In terms of absenteeism, low back pain is the main driver of productivity costs and for premature mortality the primary driver of productivity costs is coronary heart disease.

## Healthcare utilisation

Hospital inpatient and day-case costs estimated using PAFs are presented in table 4. Costs for NI are presented in PPP 2009 Irish Euro for ease of comparison.

Sensitivity analysis was performed using the upper and lower bound PAFs, which were calculated using the CIs range for the associated relative risks.<sup>6</sup> This gave a range of €125 686 873 to €216 025 571.

For NI, the PAFs used were calculated using NI-specific prevalence data for overweight and obesity. The total hospital inpatient and day-case cost attributable to overweight and obesity was €42 920 806 (with a range of €35 204 704—€54 942 260).

## Drug costs

The cost of prescribed drugs in the ROI attributable to overweight and obesity is €234 441 904, which includes all dispensing and associated costs. This estimation is based on the PAF approach which was calculated by applying the overweight and obesity PAFs to the total cost of the drugs. Cardiovascular (CVD) drugs were found to be a major contributor to drug costs with CVD costs calculated at €142 761 929. Diabetes diagnostic kit costs were estimated to be €30 638 061 and were followed by type 2 diabetes mellitus (€17 620 890), non-steroidal anti-inflammatory drugs (NSAIDs; €13 884 944), aspirin (€11 220 201), antiobesity (€8 418 288), glucosamine (€5 276 736) and topical NSAID costs (€4 620 854).

The cost of prescribed drugs in NI attributable to overweight and obesity is €77 074 272. This figure was estimated using a similar PAF method used for the ROI whereby prescribing data from the BSO was combined with PAFs to estimate total costs. Cardiovascular (CVD) drugs were reported as a substantial source of prescribed drug cost (€38 916 053), followed by diabetes (€22 233 463) and diagnostic kits (€6 676 919).

**Table 3** Breakdown of healthcare and productivity costs

	Republic of Ireland	Range €	Cost €
Healthcare costs	A. GP costs (Doherty <i>et al</i> )	15 700 000–30 000 000	22 900 000
	B. Inpatient/day case	89 589 111–179 178 223	172 849 916
	C. Outpatient (Doherty <i>et al</i> )	0–14 855 791	6 890 000
	D. Drugs	156 294 603–312 589 205	234 441 904
Productivity costs	E. Absenteeism Human capital approach	104 106 280–164 115 974	135 977 068
	F. Absenteeism Friction cost approach	54 904 907–87 400 050	72 133 090
	G. Premature mortality	493 000 000–684 000 000	592 991 594
Total	A+B+C+D+E+G	85 868 999 4–1 384 739 193	€1 166 050 482
	Northern Ireland	Range PPP € 2009	Cost PPP 2009 €
Healthcare costs	H. GP (Doherty <i>et al</i> )	0–15 210 484	7 411 564
	I. Inpatient/day case	28 613 870–57 227 740	42 920 805
	J. Drugs	51 382 848–102 765 696	77 074 272
Productivity costs	K. Absenteeism Human capital approach	215 000 000–256 000 000	235 500 000
	L. Absenteeism Friction cost approach	74 400 000–8 860 000	81 500 000
	M. Premature mortality	107 022 854–186 486 711	147 417 113
Total	H+I+J+K+L	402 019 572–617 690 631	€510 323 754

GP, general practitioner.

**Table 4** Overweight and obesity attributable to hospital inpatient and day-case costs for the Republic of Ireland and Northern Ireland in 2009

Condition	Republic of Ireland	Northern Ireland
Cancer of the colon	18 886 971	4 596 358
Cancer of the oesophagus	1 276 788	358 790
Cancer of the gallbladder	117 074	21 093
Cancer of the pancreas	2 875 482	595 706
Cancer of the breast	1 849 663	437 283
Cancer of the kidney	3 930 254	783 888
Type 2 diabetes	28 602 917	2 497 957
Cancer of the endometrium	2 735 495	840 822
Obesity	411 206	24 594
Hypertension	2 539 053	513 366
Stroke	13 284 656	4 105 929
Ischaemic heart disease	72 148 580	20 664 359
Gallbladder disease	12 493 037	4 864 114
Pulmonary embolism	5 193 900	1 264 792
Low back pain	5 293 816	993 325
Asthma	1 211 024	358 429
Total	€172 849 916	€42 920 806

### Lost productivity

For the ROI, overweight and obesity-related conditions in 2009 resulted in 266 553 claims to the IBS, made by 202 246 claimants, of whom 57.4% were female and 42.6% male. The summed 2009 duration of illness/work absence was 34 322 years. PAFs were applied to the relevant conditions to estimate absolute years lost and the percentage of the 2009 illness duration total. The total duration of illness due to overweight and obesity for 2009 was estimated at 3117 years. Overweight and obesity-related illness benefit claims accounted for 9.08% of the summed 2009 duration of all illnesses. For the human capital approach, these durations were transformed through the application of age and gender appropriate 2009 earnings into the yearly productivity loss cost estimates. The estimated annual productivity loss costs in the ROI due to absenteeism related to overweight and obesity was €135 977 068 for 2009. Productivity losses for the ROI were also estimated using the friction cost approach. In this approach, claims longer than 90 days were capped, giving a friction cost estimate for productivity loss due to overweight and obesity-related conditions of €72 133 090 for 2009.

The estimated annual productivity loss costs in NI due to absenteeism related to overweight and obesity is €215 million using the Human Capital Approach and €74.4 million using the Friction Cost Approach.

### Premature mortality

In the ROI, the estimated cost of life years lost due to obesity and overweight was calculated at a total of €853 070 261, of which €276 496 546 accounted for female deaths and €576 573 715 for male deaths. These figures are presented as income weighted years of

potential life lost for all ages based on life expectancy. The total figure represents 9% of the total income-weighted years of life lost from 2007 to 2009 in the ROI. The estimated cost of life years lost to age 75 due to overweight and obesity was €684 747 065, of which €190 542 208 accounted for female deaths and €494 204 857 accounted for male deaths. The total figure represents 8.3% of the total income-weighted potential years of life lost from 2007 to 2009 in the ROI. The basic analysis used undiscounted years of life and weights these years of life using undiscounted income. As part of the sensitivity analysis, the effect of using different discount rates, 2%, 4%, 6%, 8% and 10%, was investigated. As expected, both the absolute number of years of life lost and the corresponding costs fall sharply. The figures are shown in [table 5](#) below.

Using the Irish Department of Finance recommended discount rate of 4%, the total annual productivity loss cost estimated for the ROI, using measured BMI for prevalence rates, and only counting those who died aged 18–75 was €592 991 594.

For NI, the annual cost of premature mortality attributable to overweight and obesity was €147 417 113. By applying the upper and lower bound range relating to the range of RRs used in the analysis, the range calculated for costs is €107 022 854 to €186 486 711 million.

## DISCUSSION

This is the first comprehensive study of the cost of overweight and obesity on the island of Ireland, which allows comparisons to be made across both jurisdictions. The study focused on estimating both the healthcare and productivity costs of overweight and obesity, and although it takes a primarily top-down approach, it also draws on bottom-up approaches. The cost of overweight and obesity in the ROI was €1.16 billion, and for NI it was €510 million. NI has a population of about one-third of the ROI. Their health system is part of the UK's National Health Service (NHS) in which care is delivered free at the point of use, while in the ROI a mixed system in which a greater role is afforded private medical insurance operates. If the systems were equivalent, that is, if healthcare was also free at the point of use in the ROI, one would expect a rise in demand, with increased costs, although the fact that healthcare is

**Table 5** Sensitivity analysis around discount rates for premature mortality, both jurisdictions

Discount rate	Northern Ireland Age to 75	Republic of Ireland Age to 75
0.00%	€210 763 565.53	€8 208 337 242
2.00%	€173 995 104.01	€7 487 852 062
4.00%	€147 417 113.39	€6 878 312 466
6.00%	€127 567 162.23	€6 358 103 699
8.00%	€112 326 333.97	€5 910 531 821
10.00%	€100 345 294.30	€5 522 568 832

relatively price inelastic means that the increase in cost would be disproportionately less than the rise in demand. While the different systems might in part explain some of the differences in cost across the two jurisdictions—serving to stifle demand for services relative to that in NI and thereby deflate the cost estimation of the apparent differences—it may also relate to the use of PPP. PPP provides for the conversion of one currency to another based on the purchasing power of that currency domestically. As many of the services valued here are delivered free at the point of use, conversions based on specific comparisons, for example, of a GP consultation, were not possible. The use of general PPPs may in consequence not be ideal. If the exchange rate which was current at the time of the study was used, the cost for NI is reduced to €416 million.

While the results between the two jurisdictions were broadly along expected lines for healthcare costs, with respect to productivity costs the differences were somewhat greater than expected. This was mainly due to the amount and quality of data made available for the study of absenteeism. In the ROI, electronic data were only available for one of two relevant schemes, and so a proportion of the estimated costs was probably excluded. The data that were available were very detailed, and allowed for the number of sick days associated with overweight and obesity to be estimated with a reasonable degree of precision. Data for NI were at a much higher level, and the number of days had to be estimated. However, data for all relevant schemes were available. The crudeness of the estimates, however, meant that the estimates were much less likely to be precise. Therefore, the figure for absenteeism for the ROI can be considered an underestimate, and for NI, most likely a slight overestimate.

In the ROI, 38% of the total costs were healthcare costs, amounting to 2.7% of the total healthcare costs for that year. For NI, healthcare costs were 25% of the total and 2.8% of the total healthcare costs for 2009. These results are within the range commonly found in other European countries,<sup>25</sup> although healthcare costs in the USA tend to be higher, up to 9% of healthcare spend.<sup>11</sup>

There are a number of limitations associated with our analyses. First, omitted from the analysis were several aspects of service where additional demand is likely to emerge as a result of needs related to obesity and overweight. Such services include long-term care, social care, personal social services and also dietician services. Also omitted from the analysis are costs that fall on the individual rather than the health service. The latter could include over-the-counter medicines purchased by the individual or costs related to the consumption of GP or hospital services, such as travel, and the copayment made for drugs by private patients. Also excluded are the costs of lost production in the self-employed, which are private rather than societal costs. In each case, the rationale for the omission of the service resulted from

the absence of adequate reliable data on which to base estimates. Second, repeated cross-sectional surveys show us that the population BMI distribution is 'shifting to the right,' but the duration of obesity—the period that obese people are living with obesity—is probably also increasing and the cumulative risks of adverse health events may actually be higher than those we have used in our analyses (and the costs).<sup>26 27</sup> The duration of obesity, however, is not captured in these cross-sectional surveys. Third, studies have shown that risk measures of central adiposity may better predict aspects of morbidity than BMI.<sup>28–30</sup> While using alternate measures may have helped increase the precision of some of our estimates, BMI was the only measure of adiposity available to us. Fourth, for productivity losses due to premature mortality, the cost estimates reflect the wage rates in the ROI. There is considerable uncertainty in these estimates, reflecting the imprecision in estimates of population attributable fractions and the assumptions, approximations and simplifications inherent in this approach to estimating productivity losses.

Lastly, with respect to those elements where cost estimates were provided a number of simplifying assumptions were employed any of which are open to debate. For example, data constraints obliged the use of different methods—bottom-up and top-down—that are not directly comparable. In the top-down approach, simplifying assumptions were employed in respect, for example, of average earnings at the time of death, of the value of lost productivity among the retired, of the duration of absenteeism in NI, of the interval over which friction costs were calculated of discount rates used, etc. The use of lost output when valuing premature death as opposed, for example, to the value of a statistical life is similarly open to question. Similarly, in the bottom-up approach, alternative regression models and survey data may have resulted in alternative estimates of costs. In respect of both unobserved characteristics correlated with adiposity—for example, preferences for health or attitudes to risk—we acknowledge that we have not been able to take these into account in this study, and that the bias from such factors may well lead to an overestimate of the costs of obesity. While the precision of our estimates should in consequence be treated with some caution in the spirit of lighting a candle rather than simply cursing the dark, however, we contend that these estimates at a minimum help spark a debate in respect of costs and hopefully help to provoke a policy response.

The limitations notwithstanding, the paper provides the first comprehensive examination of the cost associated with obesity and overweight on the island of Ireland. On balance, the summary cost estimates are probably conservative, that is, likely to underestimate the true costs for the reasons detailed above. It quantifies the not insubstantial costs associated with overweight and obesity currently in both parts of Ireland. The upward trend in the prevalence of childhood and adult obesity indicates that these costs unchecked will increase



over time. Given the drive in both jurisdictions to contain healthcare spending and increase productivity, it seems unlikely that current trends will be sustainable. Given this, evidence based prevention programmes must be set in place at all levels of society to tackle this in a coordinated and sustained fashion.

Lastly, this study was constrained by a lack of suitable longitudinal or cross-sectional data to allow for a reliable bottom-up estimate of costs. The top-down approach using PAFs may have resulted in some overestimation, as these costs are average costs, and also such calculations cannot rule out double counting of cases, where multiple comorbidities coexist. The pooling of two jurisdictions (as per the funding requirements) for this study provides useful comparisons across the jurisdictions, especially as there are differing healthcare systems.

## CONCLUSION

The cost of overweight and obesity is substantial, multifaceted and likely to increase. This paper quantifies the avoidable costs attributable to overweight and obesity and should motivate policymakers to urgently consider evidence pertaining to overweight and obesity prevention strategies, and their cost-effectiveness, as part of the development of a coherent policy response.

**Contributors** AD, AC, ED, CO'N, TMcV, MRS, AS, KK, LS and JH were all involved in performing various parts of the study. AD wrote the manuscript. AD, AC, ED, CO'N, TMcV, MRS, AS, KK, SF, LS, FK, JH, KB and IJP assisted in writing, revising and reviewing the manuscript. IJP was the Principal Investigator on the overall study. He advised and assisted in the drafting and review of the manuscript. All authors read and approved the final manuscript.

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# Overweight and obesity on the island of Ireland: an estimation of costs

Anne Dee, Aoife Callinan, Edel Doherty, Ciaran O'Neill, Treasa McVeigh, Mary Rose Sweeney, Anthony Staines, Karen Kearns, Sarah Fitzgerald, Linda Sharp, Frank Kee, John Hughes, Kevin Balanda and Ivan J Perry

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## Correction

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Dee A, Callnan A, Doherty E, *et al.* Overweight and obesity on the island of Ireland: an estimation of costs. *BMJ Open* 2015;5:e006189. The correct spelling of the second author's name is Aoife Callan.



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